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METHOD OF SELECTING A PROFILE OF A DIGITAL SUBSCRIBER LINE

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FIELD OF THE DISCLOSURE

[0001] The present disclosure is related to a control system and methods of selecting profiles for digital subscriber loop (DSL) lines.

BACKGROUND OF THE INVENTION

[0002] The traditional process for making asynchronous digital subscriber line (ADSL) performance adjustments is based on measurements of line performance parameters, such as signal noise margin and relative capacity. These line performance parameters do not directly measure the actual data transfer rate provided by an ADSL connection. Further, line performance adjustments are typically made using a manual process that depends on a particular technician's preferences, experience, and judgment. This manual process often leads to inaccurate performance adjustments and is typically error-prone. Even after an ADSL line has been adjusted, the actual data transfer performance of the ADSL line may be better, the same, or may be worse since the customer experience and data transfer rates are not directly measured or calculated during the adjustment process.

[0003] Accordingly, there is a need for an improved method and system of adjusting DSL line performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 is a block diagram that illustrates a DSL control system.

[0005] FIG. 2 is a flow chart that illustrates an embodiment of a method of selecting a profile of a DSL line.

[0006] FIGs. 3-6 are general diagrams that illustrate graphical displays that may be provided to a user of the system of FIG. 1 in connection with DSL profile selection.

DETAILED DESCRIPTION OF THE DRAWINGS

[0007] The disclosure presents an ADSL line performance adjustment method and system that measures and responds to profile performance parameters, such as code violations, signal noise margin and relative capacity.

[0008] An ADSL user's experience is determined by the level of TCP/IP data packet throughput the user receives. When an ADSL line's condition degrades due to lowered signal noise margin (SNM), increased impulse noise, increased interference, or other adverse conditions, the line may experience dramatic increases of code violations, which means data integrity has been violated. The code violations, if unable to be corrected by the forward error correction (FEC) of the ADSL coding algorithm, result in TCP/IP packet re-transmission. The TCP/IP re-transmissions in turn lowers overall TCP/IP throughput.

[0009] If an ADSL line experiences a high degree of code violations, it might need to be moved to a lower speed profile that is more resistant to noise, or moved to an interleaved channel profile (if it is currently running at a fast channel profile) where the interleaving provides superior error correction ability. The line's code violation count can be greatly reduced with an appropriate new line profile. But, a lower speed profile or interleaved channel profile results in lower line speed. (In the case of interleaved channel profiles, lowered speed is the result of the delay that comes from frame scrambling and buffering). Therefore, whether or not a troubled line needs a new profile and which new profile

should be selected depends on the line profile that can achieve higher TCP/IP throughput (current profile with higher line speed and higher code violations or lower speed profile or an interleaved channel profile with lower code violations).

[0010] The present disclosure provides a method that can be used to determine when a line should be moved to a different profile in order to increase its TCP/IP throughput. The disclosed system and method is useful for typical user web browsing, since the throughput of various TCP/IP applications is affected differently by code violations.

[0011] Referring to FIG. 1, a system that may be used to select profiles and to adjust digital subscriber line performance is shown. The system includes a controller 100, a DSL code violation measurement unit 102, a profile database 106, and a data packet throughput storage module 108. The controller 100 is also coupled, either directly or remotely, to a terminal device 104 that includes a display 130. The DSL code violation measurement unit 102 is responsive to and takes measurements of DSL lines 110. The controller 100 includes a processor 120 and a memory 122. The memory includes a profile selection software routine that may be executed by the processor 120. The controller 100 is coupled to the profile database 106, the data packet throughput measurement unit 108, and the DSL code violation measurement unit 102. The controller 100 receives DSL profiles 140 from the profile database 106, and receives data packet throughput data 142 from the data packet throughput data unit 108. The controller 100 receives code violation data 144 from the DSL code violation measurement unit 102. The controller 100 provides reports, including graphical displays and charts, on the display 130 of the terminal device 104. In a particular embodiment, the terminal device 104 is a remote device that includes a web browser interface and is coupled to the controller via a distributed data network.

[0012] Referring to FIG. 2, an illustrative method of selecting a profile to be applied to a DSL line is shown. At step 202, the method includes the step of determining a number of code violations of the digital subscriber line. A first estimated data packet throughput value associated with a first profile based on the number of code violations is determined, at 204, and a second estimated data packet throughput value associated with a second

profile based on the number of code violations is determined, at step 206. A profile to be applied to the digital subscriber line is selected, at step 208. The profile selected is based on a comparison of the first estimated data packet throughput value and the second estimated data packet throughput value. For example, the profile that has the highest estimated data packet throughput value may be selected. An example of a data packet throughput value is a TCP/IP throughput value. After the profile is selected, the selected profile may be applied to the DSL line, at step 210.

[0013] As shown at step 212, the illustrated method steps 202-210 may optionally be repeated for a plurality of different DSL lines. In a sample network, there may a vast number of DSL lines, and a selected profile may be determined for each of the DSL lines. The above described method may be automatically performed using a computer system to determine a selected profile that provides the highest TCP/IP throughput value. The TCP/IP throughput value estimates are based on code violation counts and these estimates and estimate curves are determined based on laboratory test data. In this manner, an automated system and method has been described to provide for increased TCP/IP packet transfer performance over an entire network of DSL lines. An example of an automated system is to use the system of FIG. 1 where the profile selection routine 124 within the controller 100 is a computer program that performs the operational steps and computations illustrated in FIG. 2.

[0014] The TCP/IP packet transfer rate is useful since this data packet rate is tied to the performance experienced by the end customers. For example, the transfer rate provides the speed that a given website is displayed and downloaded onto an end DSL subscriber's computer while that subscriber is surfing the internet.

[0015] Referring to FIGs. 3-6, a plurality of graphical displays 300, 400, 500, and 600 are shown. Each of the graphical displays shows a graphical chart that may be provided on the display 130 of the terminal device 104. Each of the graphical displays include a first display curve for a first profile, a second display curve for a second profile, and a third display curve for a third display profile. Each display curve is formed from a plurality of TCP/IP throughput data points at a particular number of measured code

violations for a particular DSL line. For example, the first display curve referenced in FIG. 3 is a fast speed profile at a transmission speed of 1536 kbits per second. The second profile referenced in FIG. 3 is an interleaved channel profile also at 1536 kbits per second. The third display curve is a fast speed profile at the reduced speed of 768 kbits per second. As the number of code violations increase, such as due to increased DSL line noise, the preferred profile changes from the first display curve to the second display curve at an intersection point between data points 315 and 661, at a noise level of about 58 millivolts, as shown in FIG. 3. The number of code violations corresponds to the magnitude of noise that is injected into a particular DSL line.

[0016] The first curve has a second intersection point with the third curve at a higher level of noise/code violations. As shown in FIG. 3, the second intersection point is between the data point at 661 and the data point of 2309 code violations, at about 60.4 millivolts of noise. Thus, for the particular example shown in FIG. 3, the disclosed profile selection method would select the first profile (with the first profile display curve) for code violation measured readings of 0, 44, 130, and 315 and would selected the second profile (with the second profile display curve) at the code violation reading of 661. The third profile would be selected for increased noise leading to code violations above the point of intersection between the 768 curve and the 1536 fast curve, at approximately 2000 code violations. The number of code violations shown is the count of detected code violations accumulated during a time period of fifteen minutes. Other time periods may be used such as intervals of 30 minutes or hourly. In addition to the fixed data points shown, the curves can be prorated and intersection points extrapolated to make profile selections. For example, for a DSL line with a fast (i.e. noninterleaved) speed of 1536 kbits per second (kb/s), when this line experiences more than about 450 code violations every 15 minutes, the line should be switched to the 1536 kbits per second interleaved profile.

[0017] Referring to FIG. 4, a TCP/IP throughput vs. Code Violations for impulse noise graphical display is shown for a DSL line that starts with a 768 (kb/s) fast speed profile. This diagram shows profile selection transition points between the 768 kb/s interleaved profile and the 384 fast (i.e. non-interleaved) profile. FIG. 5 shows a similar chart for

384 kb/s and 192 kb/s profiles, and FIG. 6 shows a similar chart for a 192 kb/s and a 192 kb/s interleaved profile.

[0018] Unlike traditional ADSL optimization, which is based solely on line performance parameters such as code violations, signal noise margin and relative capacity, the method presented is based on both TCP/IP throughput and ADSL layer parameters. The method and system presented is based on experimental results of lab testing, while traditional ADSL optimization relies on individual service technicians' preferences.

[0019] The method and system disclosed produces clear criteria to determine when a line should be switched to another profile, and provides better TCP/IP throughput and therefore, better user experience. Since this method is based on TCP/IP throughput, ADSL users can determine how much faster they can download a file after switching to another profile.

[0020] The above disclosed subject matter is to be considered illustrative, and not restrictive, and the appended claims are intended to cover all such modifications, enhancements, and other embodiments which fall within the true spirit and scope of the present invention. Thus, to the maximum extent allowed by law, the scope of the present invention is to be determined by the broadest permissible interpretation of the following claims and their equivalents, and shall not be restricted or limited by the foregoing detailed description.